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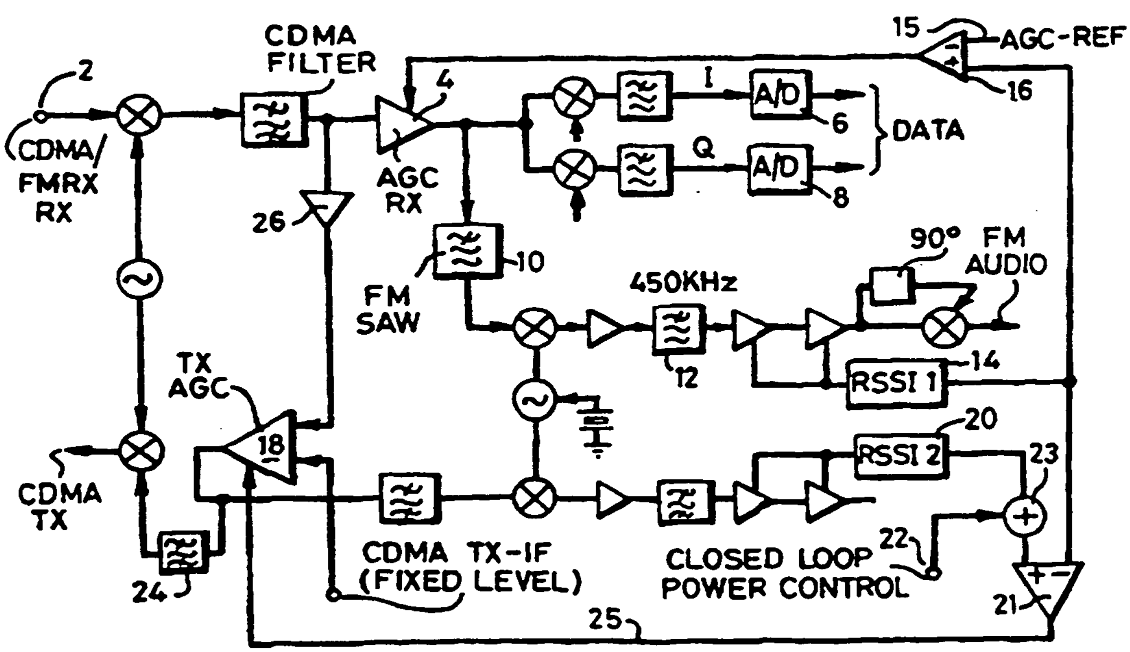

(57) Abstract

A power control system for a CDMA cellular telephone system comprising means for generating a first signal (14) representing received signal strength; means for generating a second signal (20) representing transmitted signal strength; comparator means (21) for generating an error signal (25) from the difference of the first and second signals; and gain control means (18) for adjusting the transmitted signal strength in accordance with the error signal until the first and second signals are equal.

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"CDMA Power Control"

This invention relates to power control in a spread spectrum code division multiple access cellular telephone system (TIA:IS-95). Such systems normally employ so-called "open loop" and "closed loop" power control.

Open loop power control requires that the automatic gain control stages in the receiver and transmitter of the mobile should track, i.e. for every 1dB increase in the receiver input level, the transmitter output level should decrease by 1dB and vice versa. Since the dynamic range of the AGC system is some 80dB, this is quite difficult to achieve, especially over a range of temperatures.

Closed loop power control requires the mobile transmitter to increment or decrement the output level in 1dB steps in response to commands from the base station.

Normally open and closed loop AGC systems are implemented either by relatively simple variable gain/attenuation devices in the RX and TX chains which require extensive calibration, or sophisticated temperature compensated variable gain MMICs which still require (simpler) calibration.

The present invention seeks to provide a power control system which can utilise readily available and cheap analogue cellular components and which is inherently self

calibrating.

Accordingly the present invention provides a power control system for a CDMA cellular telephone system comprising means for generating a first signal representing received signal strength; means for generating a second signal representing transmitted signal strength; comparator means for generating an error signal from the difference of the first and second signals; and gain control means for adjusting the transmitted signal strength in accordance with the error signal until the first and second signals are equal.

Preferably, gain control means are provided for the received signal input, by comparing the output of the means for generating the first signal, with a reference level, and adjusting the gain until they are equal.

Preferably, the output from the second signal generating means is also modified by a closed loop power control signal, before it is supplied to the comparator.

A preferred form of the present invention therefore provides a power control system for a CDMA cellular telephone system comprising means for supplying the received (RX) CDMA signal to the input of a RX-AGC circuit which is arranged to provide a constant level input for RX-A/D converters by setting the gain to be inversely proportional to the received signal level; means for tapping off the RX-AGC output, and means for filtering the tapped-off signal to reject possible interfering signals and to generate a first

received signal strength voltage (RSSI 1); means for supplying the received CDMA signal to the input of a transmit (TX) AGC; means for generating a second received signal strength voltage (RSSI 2) from the output of the TX-AGC; means for comparing the first and second RSSI voltages and producing a difference signal which is used to adjust the TX-AGC until the RSSI voltages are equal.

Preferably, the second RSSI voltage is also summed with a closed loop power control signal so as to increment or decrement the TX output in response to commands from a base station.

One embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a block diagram of the overall arrangement of the circuitry;

Figure 2 is a schematic diagram of an AGC amplifier.

The received CDMA signal (2) is downconverted to an IF and passes through an RX-AGC amplifier (4). The gain of the amplifier is adjusted by the AGC system to ensure that the receive A to D converters (6, 8) are driven at a constant level i.e. the gain is inversely proportional to the received power level. The AGC amplifier may for example be a simple circuit using dual gate FETs, the second gate being used for gain control, in a well-known manner. For example, as shown in Figure 2, a dual gate FET 30 is driven by the input signal (32) at gate g2, while an AGC signal

(34) is applied at gate g1 to provide an output (36).

The CDMA cellular system has to coexist with conventional analogue cellular systems which in practice means that there could be strong interfering signals as close as 900 kHz from the wanted CDMA signal which could cause false RX power measurements if there is insufficient filtering. The filtering is normally provided by a SAW filter at the IF and a steep rolloff low pass filter at baseband. Due to the wideband nature of CDMA(+/- 630kHz), significant rejection at 900kHz is difficult to achieve both technically and cheaply.

The CDMA signal is also tapped off and filtered first by a conventional FM IF filter (10). Most FM cellular receivers employ a second Intermediate Frequency of 450 or 455 khz which means that the first IF filter must provide approximately 70db of rejection at +/- 900kHz (the "image" frequency). The signal then passes into an FM IF chip, converted down to a second IF of say 450kHz, filtered further (12) and a receiver signal strength voltage (14) generated which is compared to a reference (15) in a comparator (16) to produce a gain control voltage for the receiver AGC amplifier.

The RX CDMA signal, prior to amplification, is also fed into the TX AGC amplifier (18) (similar circuit to the RX circuit) and the output level measured in a similar FM IF chip producing a second RSSI voltage (20). A closed loop power control voltage is also added (22) to the second RSSI

voltage at a summer (23) to increment or decrement the power level in response to commands from the base station. The gain of the TX AGC amplifier is adjusted (21) using the difference signal (25) of the two RSSI voltages. For a closed loop control voltage (22) input of zero, the gains of the RX and TX AGC stages are equal. In practice, a gain offset is normally required because the TX IF signal level at the input of the TX AGC amplifier (18) is substantially higher than the RX-IF input level to the RX AGC amplifier 4 and thus gain is provided by an amplifier (26). A filter (24) is required at the output of the TX AGC amplifier (18) to prevent the RX IF signal being retransmitted.

Various easily available components may be utilised to construct the circuitry. Many manufacturers offer FM IF receiver devices with an RSSI characteristic which is very stable over temperature. Ideally RSSI-1 and RSSI-2 should have identical characteristics (i.e. slope, intercept and temperature coefficient). Toshiba offer a suitable device, TA31138FN "Dual MIxer and IF Amplifier for Diversity Reception" for a Japanese Digital Cellular system, employing spatial diversity and therefore requiring two matched IF chains, as shown in the data sheet attached hereto as Appendix A.

Many FM IF chips have a highly linear RSSI characteristic. This can be exploited for closed loop power control by adding an adjustment voltage to the output of RSSI-2. The RSSI sensitivity (mV per dB) can be easily

measured during manufacture of the telephone.

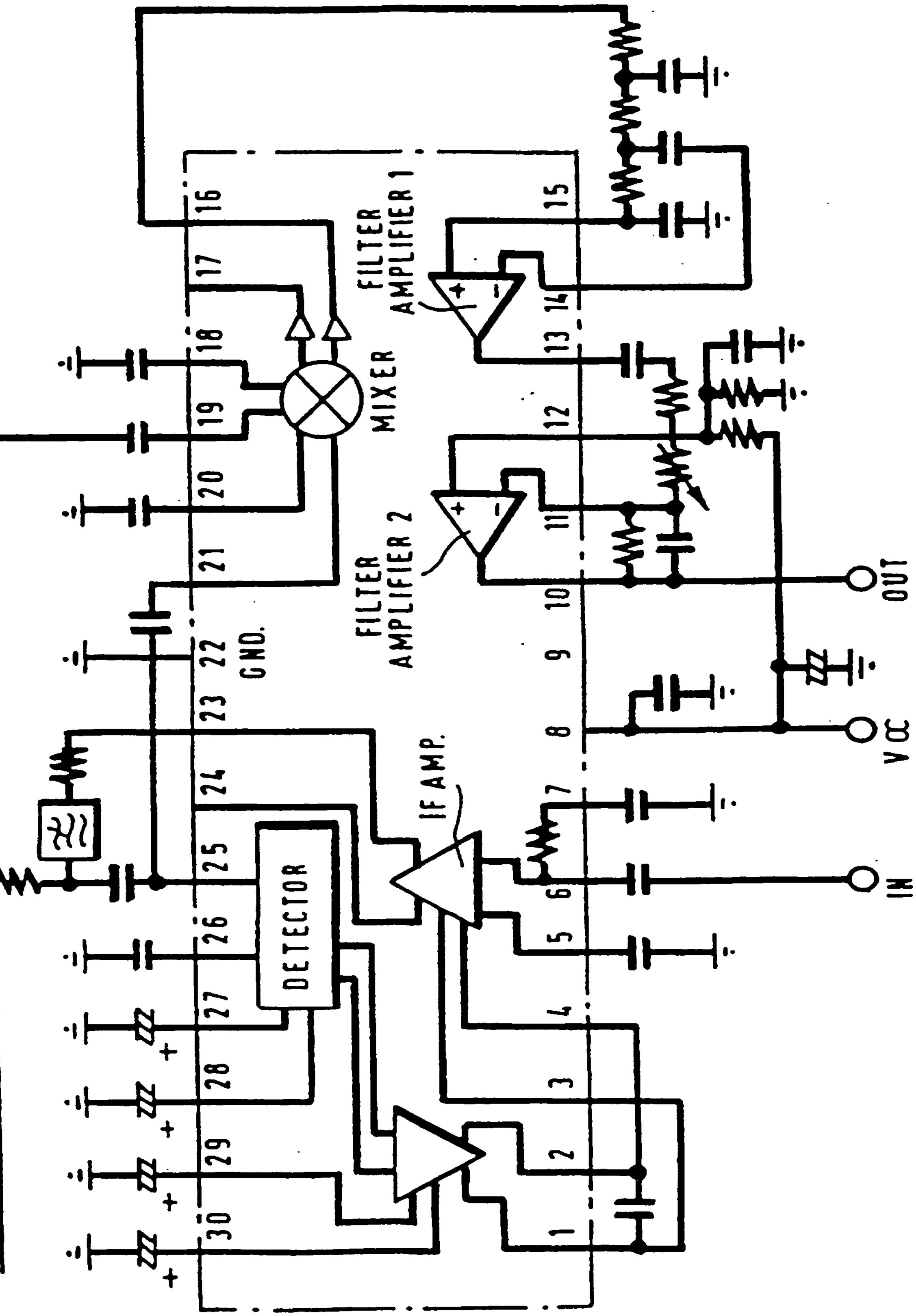
The preferred form of the invention has a number of advantages. The 900kHz filtering function is performed by cheap, readily available components.

In dual mode applications (CMDA/AMPS or CDMA/ETACS), the FM SAW filter, IF amplifier-1 and one of the second IF filters (12) can be used for FM demodulation.

The "turn around" performance of the open loop power control or the ability of the RX and TX AGC circuits to track is a direct function of only how well the two FM IF circuits match (the Toshiba device should achieve +/- 1dB over temperature).

Closed loop power control accuracy is a function of the linearity of the FM IF chip circuit only.

APPENDIX A


3rd LOCAL
MIXER
FILTER AMPLIFIER 1
FILTER AMPLIFIER 2
GND.
IF AMP.
DETECTOR
OUT
Vcc
IN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

CLAIMS

1. A power control system for a CDMA cellular telephone system comprising means for generating a first signal (14) representing received signal strength; means for generating a second signal (20) representing transmitted signal strength; comparator means (21) for generating an error signal (25) from the difference of the first and second signals; and gain control means (18) for adjusting the transmitted signal strength in accordance with the error signal until the first and second signals are equal.

2. A power control system according to claim 1 further characterised by gain control means (16) for the received signal input, which is adapted to compare the output of the said means for generating the first signal, with a reference level (15), and to adjust the gain until they are equal.

3. A power control system according to claim 1 or claim 2 further characterised by means (23) for modifying the output from the second signal generating means in accordance with a closed loop power control system (22), before it is supplied to the comparator (21).

4. A power control system for a CDMA cellular telephone system comprising means for supplying the received (RX) CDMA signal to the input of a RX-AGC circuit (4) which is

arranged to provide a constant level input for RX-A/D converters by setting the gain to be inversely proportional to the received signal level; means for tapping off the RX-AGC output, and means for filtering the tapped-off signal to reject possible interfering signals and to generate a first received signal strength voltage (RSSI 1); means for supplying the received CDMA signal to the input of a transmit (TX) AGC (18); means for generating a second received signal strength voltage (RSSI 2) from the output of the TX-AGC; and means (21) for comparing the first and second RSSI voltages and producing a difference signal (25) which is used to adjust the TX-AGC (18) until the RSSI voltages are equal.

5. A power control system according to claim 4 in which the second RSSI voltage (RSSI2) is also summed with a closed loop power control signal (22) so as to increment or decrement the TX output in response to commands from a base station.

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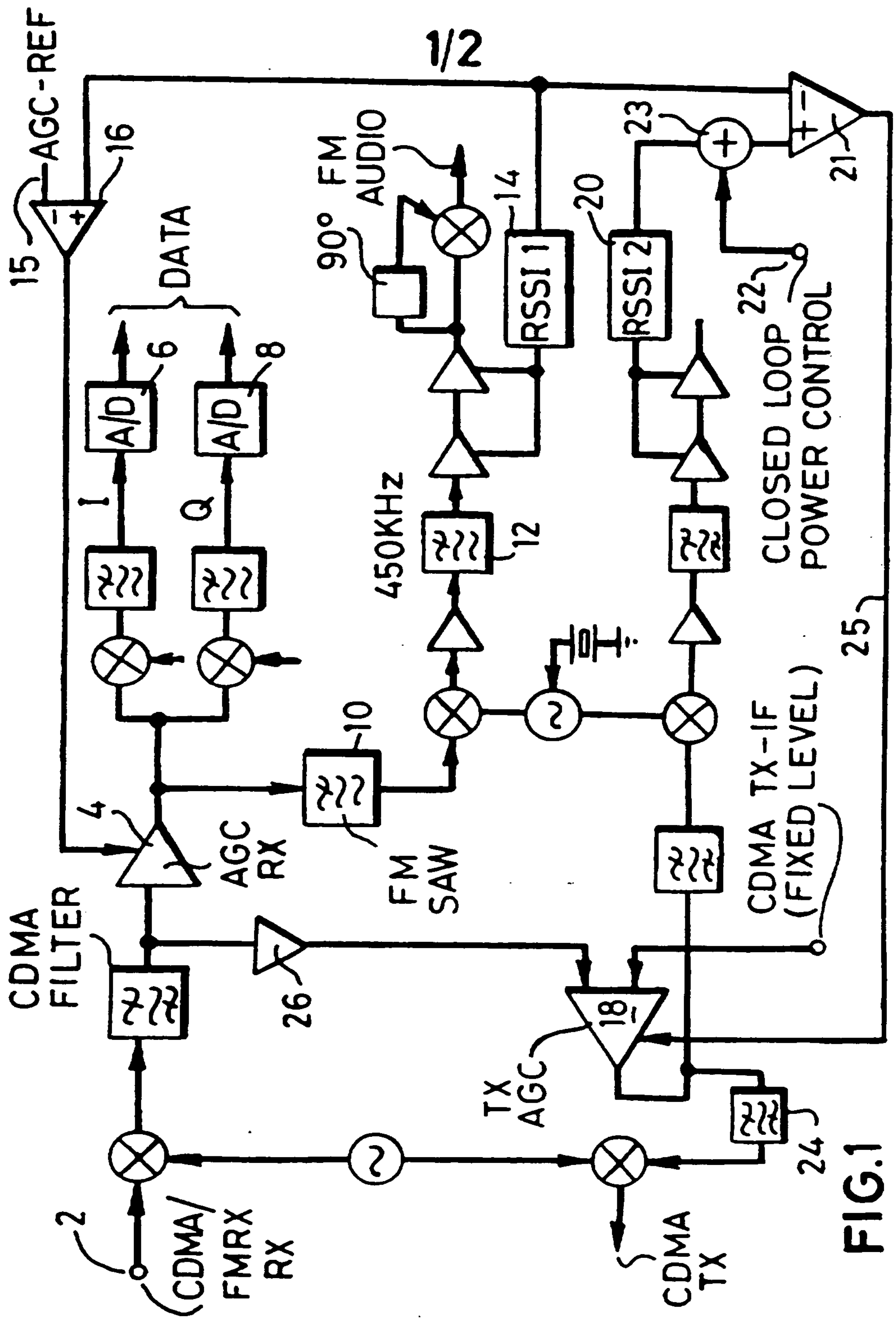
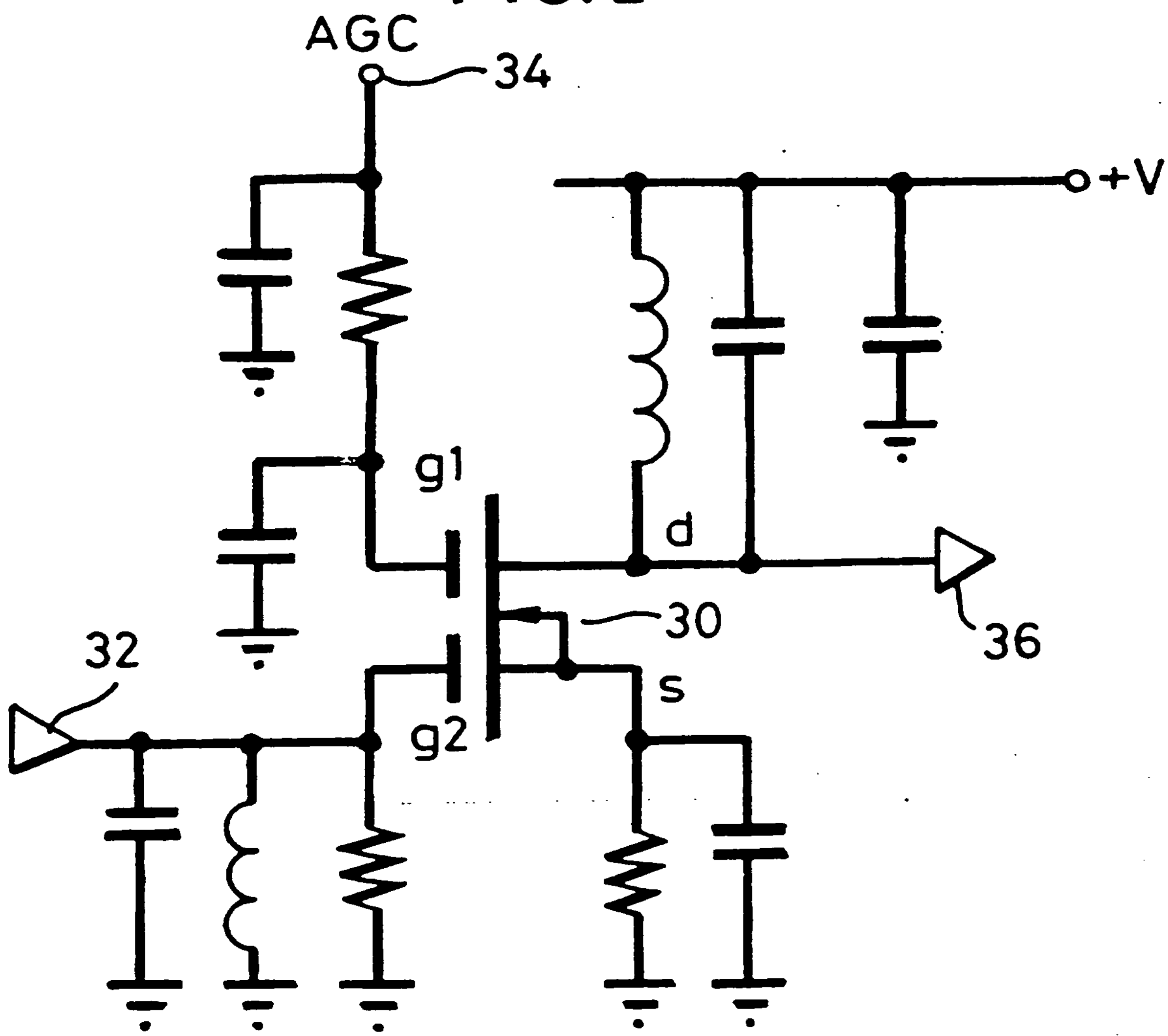

AGC-REF
15
16
DATA
I
Q
A/D
6
8
90° FM AUDIO
14
RSSI 1
450KHz
12
20
RSSI 2
23
21
22
CLOSED LOOP POWER CONTROL
25
10
4
AGC RX
FM SAW
CDMA FILTER
26
CDMA TX-IF (FIXED LEVEL)
18
TX AGC
24
2
CDMA/ FMRX RX
CDMA TX

FIG.1

FIG. 2



INTERNATIONAL SEARCH REPORT

Intern. al Application No
PCT/GB 97/00864

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B7/005 H04Q7/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04B H04Q H03G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 94 06218 A (ERICSSON TELEFON AB L M) 17 March 1994	1,2
Y	see page 3, line 8 - line 23 see figure 2	3-5
Y	WO 93 07702 A (QUALCOMM INC) 15 April 1993 * abstract * see page 8, line 18 - page 9, line 3 see page 16, line 4 - line 16 see page 25, line 22 - page 26, line 7 see figure 5	3-5

☐ Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9406218 A	17-03-94	AU 672628 B	10-10-96
		AU 4988393 A	29-03-94
		CN 1086945 A	18-05-94
		EP 0611499 A	24-08-94
		FI 942033 A	04-05-94
		JP 7504077 T	27-04-95
		NZ 255617 A	26-11-96
WO 9307702 A	15-04-93	US 5267262 A	30-11-93
		AU 654891 B	24-11-94
		AU 3054392 A	03-05-93
		BG 98704 A	31-05-95
		BR 9206606 A	14-11-95
		CA 2120768 A	15-04-93
		EP 0607359 A	27-07-94
		FI 941637 A	08-06-94
		HU 69842 A	28-09-95
		IL 103368 A	19-01-96
		JP 7502631 T	16-03-95
		NO 941264 A	08-06-94
		ZA 9207539 A	07-07-93